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USE OF ACID WHEY IN TECHNOLOGY OF ENRICHED JELLY DESSERT

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ABSTRACT

Jelly based on milk whey is recommended for all population groups as a functional product for increasing immunity, especially for people with connective tissue diseases, cardiovascular diseases, high blood pressure, metabolic disorders, and diabetis. To improve the technological properties of the product, the dietary fibre was swollen in the acid whey mixed with water. The solubility of pectin improved with an increase in temperature. According to the results of the study, the nutritional value of the test sample exceeded the one of the control sample in the content of dietary fibre (which was achieved by adding citric fibre to the jelly) and the content of essential macro- and microelements - Ca, Mg, Zn and P (by replacing water with the acid whey). Thus, the developed product along with the functional properties had an increased biological and nutritional value and possessed high organoleptic characteristics.

1.Introduction

One of the most promising areas for food industry is currently the development of healthy food products, including those enriched with functional ingredients (Tihomirova, 2001).

The production of desserts on the basis of secondary dairy raw material allows to make the diet more various, and improve the taste of the product, reducing its cost (Yadav, et al., 2016).

Milk whey is a by-product in the production of protein-fat products, such as cheese, cottage cheese, casein (Boland, 2011). The yield of milk whey from 1 ton of milk in the production of high-protein products ranges from 65 to 82%: natural cheeses – 80%; defatted cheeses– 65%; low-fat cheeses – 65%; brynza – 65%; cottage cheese – 80%; technical casein – 75%; food casein – 82% (Jeewanthi, et al., 2015; Smithers, 2008).

It's clinically proved that the use of whey products can be effective in the treatment and prevention of diabetes, bowel diseases, hypertension, infections, diseases of integumentary and bone tissues, immunodeficiency, complications after surgery (Jayaprakasha, et al., 1999; Jelen, 2009).

Moreover, it is established that whey proteins influence the feeling of satiety (so that a person can eat less), and the speed of digestion, which allows to control one's weight (Yetmin, et al., 2001).

Dietary fibre is one of the most popular and most widely used food ingredients due to its multifunctionality. On the one hand, dietary fibre is used as technological additives that changes the structure and chemical properties of food products, on the other hand, dietary fibre is an excellent functional ingredient that can have a beneficial effect both on individual systems of the human body and on the whole organism (Petrov, et al., 2001).

Citrus dietary fibre is extracted from the cellular material of dried citrus pulp mechanically, without any chemical reagents, by opening and expanding the structural cell of citrus fibre. It possesses a high fat-binding capacity, emulsifying, stabilizing, structure-forming properties, antioxidant effect, reduces

contamination by microorganisms, thereby increasing the shelf life and improving the freshness of food products, it is resistant to cycles of frosting and defrosting. It improves nutritional value, being a product of functional purpose, thanks to the content of dietary fibre, beneficial for human health (Kosikowski, 1979; Alamri, et., 2014).

A rational way of processing acid whey is the production of various structured desserts on its basis (Pescuma, et al., 2015).

During the study we faced the task of developing a new kind of enriched product, jelly dessert by way of example. Acid whey rich in minerals and essential nutrients was chosen as an enriching component, and citrus pectin «Citrus Fibre 7000» as a stabilizing component and a source of dietary fibre (Kozlov, 2004).

The nutritional trend for foods enrichment has been and is very important. However, when new components are incorporated into an existing dairy formulation, the effect of such modification on food properties should be researched.

Jha et al. developed a process to extend the shelf life of a dairy dessert enriched with dalia (cooked and shredded wheat) and determined its physicochemical properties (Jha, et al., 2012).

Qasem et al. carried out a study of high soluble-fiber pudding by incorporating okra (2–8%) in a dessert formulation, trying to improve both the rheological (flow and texture) and nutritional (soluble fiber) properties of desserts and refer good results for the 2% incorporation level (Qasem, et al., 2016).

In the light of the above, the development of technology and formula for food products with dietary fibre is a relevant task. In addition, the use of secondary dairy raw materials (milk whey) as a basis for such products simultaneously solves the problems of ensuring the adequate nutrition of the population, and using all milk components to the full, which in turn affects the cost of finished products, minimizing waste disposal costs (Tutelian, et al., 2000).

2. Materials and methods

2.1. Materials

As the object of the study, the orange jelly recipe, listed in the collection of recipes for catering, was used. The recipe included orange juice without pulp, gelatin, sugar, water and citric acid.

In our technology, water was replaced with acid whey, and Citrus Fibre 7000 (manufactured by Bernello Ingredients GmbH) was used as the stabilizing and functional-technological component.

2.2. Methods

The content of dry substances was determined by the hydrometric method. The arithmetic mean of the results of two indications ρ_1 and ρ_2 obtained under repeated conditions was taken for the average value of the hydrometer readings at the temperature of the sample (20.0±2.0) °C.

The mass fraction of lactose was determined using Shimadzu LC-20 Prominence liquid chromatograph equipped with spectrophotometric and refraction index detectors; an aminopropyl stationary phase column for the separation of carbohydrates (Zorbax Carbohydrate 250x4.6 mm, 5 μm, manufactured by Agilent) and the corresponding pre-column). The method was based on the determination of lactose in a filtrate obtained after removal of fat and protein from the sample by high performance liquid chromatography when separated on an anion exchange column. The obtained measurement results were compared with the values of the mass fraction of lactose in a standard sample using a calibration curve.

The mass fraction of protein was determined by a Kjeldahl-based method of the sample's mineralization and photometric measurement of the indophenol blue colour intensity, proportional to the amount of ammonia in the mineralase.

The content of milk fat was determined by the acid method. The method was based on the release of fat from the whey under the action of concentrated sulfuric acid and isoamyl alcohol,

followed by centrifugation and measurement of the volume of released fat in the graduated part of the oleometer.

The acidity of the whey was determined by titrating it with an alkali solution in the presence of phenolphthalein.

The density was determined using a lactodensimeter.

The temperature and time of swelling and dissolution of dietary fibre were determined by the test tube method. The method was based on the evaporation of water from the product during heat treatment and determining the change in its mass by weighing.

The content of vitamin C was determined by the fluorimetric method on Fluorat-02 fluid analyzer. The method was based on extracting vitamin C from a food product, treating the extract with activated carbon in order to purify it and simultaneously oxidize ascorbic acid to dehydroascorbic acid, which interacts with o-phenylenediamine in a weak acid medium to form a fluorescent product, and registering the fluorescence on a Fluorat-02 analyzer.

Dietary fibre was determined by enzymatic-gravimetric method. The method was based on enzymatic hydrolysis of starch and non-starch compounds. Dietary fibre was precipitated with ethyl alcohol, dried and its content was determined gravimetrically (Pascual, et al., 2000).

The content of calcium, magnesium and zinc in products was determined with MGA 915/1000 atomic absorption spectrometer with electrothermal atomization. The method was based on measuring the resonant absorption of light by free metal atoms, which occurs when it passes through a layer of atomic vapor in an electrothermal atomizer of an atomic absorption spectrometer.

The mass concentration of elements is determined by the value of the integral signal of absorption and is calculated automatically according to a pre-set calibration curve.

The phosphorus content was determined using its ability combining with ammonium molybdenum to form phosphomolybdic acid, which was reduced by the amidol reagent and gave a blue color (Skurikhin, et al., 1998).

To conduct an organoleptic evaluation of Jelly Dessert a 9-point scale was used, with weight coefficients taken into the account.

All analyses were carried out in triplicate unless otherwise stated and the average values were calculated. The results were expressed as mean value ± standard deviation. Significant differences between mean values at significance level $p<0.05$ were established using the One way analysis of variance and Student`s test. Microsoft Excel version 2010 was used as the statistical analysis software.

3.Results and discussions

Milk processing enterprises in Chelyabinsk region produce a lot of cottage cheese, and therefore the search for optimal ways of processing acid whey – a valuable secondary resource – is a relevant task.

The physical, chemical and organoleptic parameters of the acid whey are given in Table 1.

Table 1. Physical, Chemical and Organoleptic Parameters of Acid Whey

Parameter	**Characteristics**
Dry substances, %	6.8±0.09
including:	
lactose	3.1±0.05
protein	1.1±0.08
milk fat	0.2±0.08
Acidity, °T	73
Density, kg/m^3	1026
Appearance and consistency	Homogeneous liquid. Possible protein precipitate

Colour	Pale-yellow
Taste and smell	Characteristic of whey, sour

As can be seen from Table 1, acid whey contains a significant amount of mineral substances, which explains its biological value. Globular proteins in the whey – 65% β-lactalbumin, 25% α-lactalbumin and 8% serum albumin – are well absorbed by the body (Kosaric, et al., 1982).

Citrus Fibre 7000 is a cream powder made from dried orange pulp. The taste and smell are neutral.

Citrus pectin gives the product the desired structure without adding calcium cations and does not react to the pH value.

We determined the parameters of swelling and dissolution of pectins used in the study (see Table 2).

Table 2. Parameters of Swelling and Dissolution of Dietary Fibre

Concentration, %	**Swelling Parameters**		**Dissolution Parameters**	
	time, minutes	*temperature, °C*	*time, minutes*	*temperature, °C*
0.5	10	20	20	60
1	20	20	30	60
1.5	30	20	40	60
2	45	20	50	60
2.5	50	20	60	60
3	60	20	65	60

Taking into account the organoleptic characteristics of the secondary dairy raw material under study, and the difficulty in extracting valuable food components from it, it is advisable to preserve the biopotential of the acid whey by changing its aggregate state and enhancing the flavor and aromatic characteristics. In other words, the best solution is to develop a jelly dessert based on whey with the addition of orange juice, a consistency regulator and a flavor component (Yadav, et al., 2015).

Table 3. Formula of Jelly Dessert Based on Acid Whey

Ingredient	**Quantity, g**
Orange juice without pulp	200
Sugar	140
Citric acid	1
Gelatin	30
Acid whey	620
Citrus Fibre 7000	9

A series of preliminary model experiments were carried out to select the optimal ratio of the formula components of the target product (see Table 3) and justify the technology of its production.

A classic recipe of jelly dessert based on orange juice (without pulp), gelatin, water and sugar was used for the control sample.

The production of the enriched jelly dessert was based on the abovesaid recipe, with water replaced by acid whey and citrus fibre added. Prepared gelatin was added to the whey heated with sugar to 60 °C. After the gelatin dissolved, juice extracted from oranges and the citrus fibre powder were added. Then citric acid was added and the mixture was stirred constantly for 2 minutes. The mixture was allowed to cool to the room temperature, then poured into molds and cooled off.

To improve the technological properties of the product, the dietary fibre was swollen in the acid whey mixed with water. The solubility of pectin improved with an increase in temperature.

As can be seen from the formula in Table 3, the development of an enriched product does not require expensive raw materials and additional equipment, which positively influences the cost of the dessert.

The citric dietary fibre contained in the developed product is an essential component of human nutrition (the daily requirement is 25 g), as it promotes the normalization of the gastrointestinal tract. It also stabilizes the consistency of the finished product by pre-dissolution in the mixture before homogenization and subsequent swelling.

At the next stage of the study, we tested the physical and chemical parameters of the control sample (the jelly was prepared according to the traditional formula) and the test sample (the jelly based on acid whey). The physical and chemical parameters and nutritional value of the jelly are given in Table 4.

Table 4. Physical and Chemical Parameters and Nutritional Value of Jelly

Parameter	**Control Sample**	**Test Sample**
Acidity, °T	15 ± 0.04*	32 ± 0.02*
Mass fraction of soluble solids, %	17.4 ± 0.04*	41.5 ± 0.05*
Mass fraction of vitamin C, mg%	53.3 ± 0.07*	55.5 ± 0.06*
Mass fraction of dietary fibre, %	not detected	1.9 ± 0.09*
Calcium content, mg kg^{-1}	103.83 ± 14.21*	212.83 ± 29.47*
Magnesium content, mg kg^{-1}	87.32 ± 31.11*	241.49 ± 40.51*
Zinc content, mg kg^{-1}	6.13 ± 0.87*	17.05 ± 1.01*
Phosphorus mass fraction, %	0.110 ± 0.010*	0.189 ± 0.013*

Note: * denotes statistically significant difference at p <0.05 level

According to the results of the study, the nutritional value of the test sample exceeded the one of the control sample in the content of dietary fibre (achieved by adding citric fibre to the jelly) and the content of essential macro- and microelements - Ca, Mg, Zn and P (by replacing water with the acid whey).

At the final stage, an organoleptic evaluation of the jelly dessert was carried out.

The organoleptic evaluation of the samples is shown in Fig. 1 and 2.

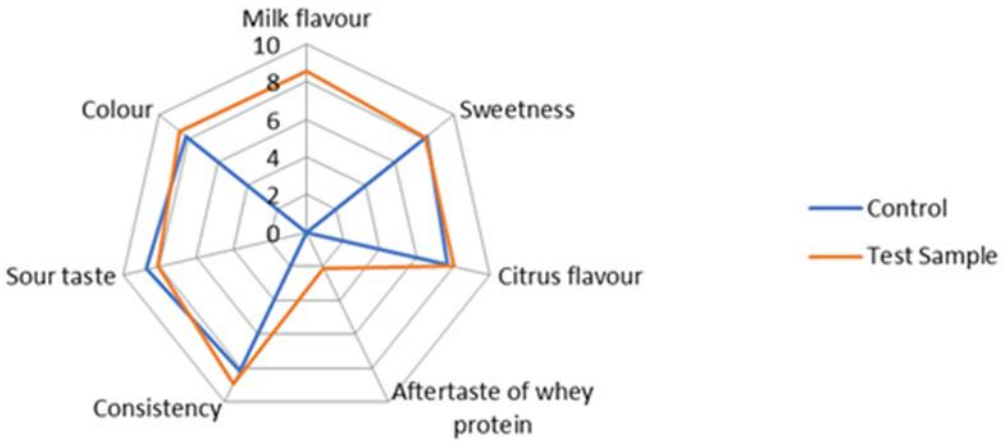
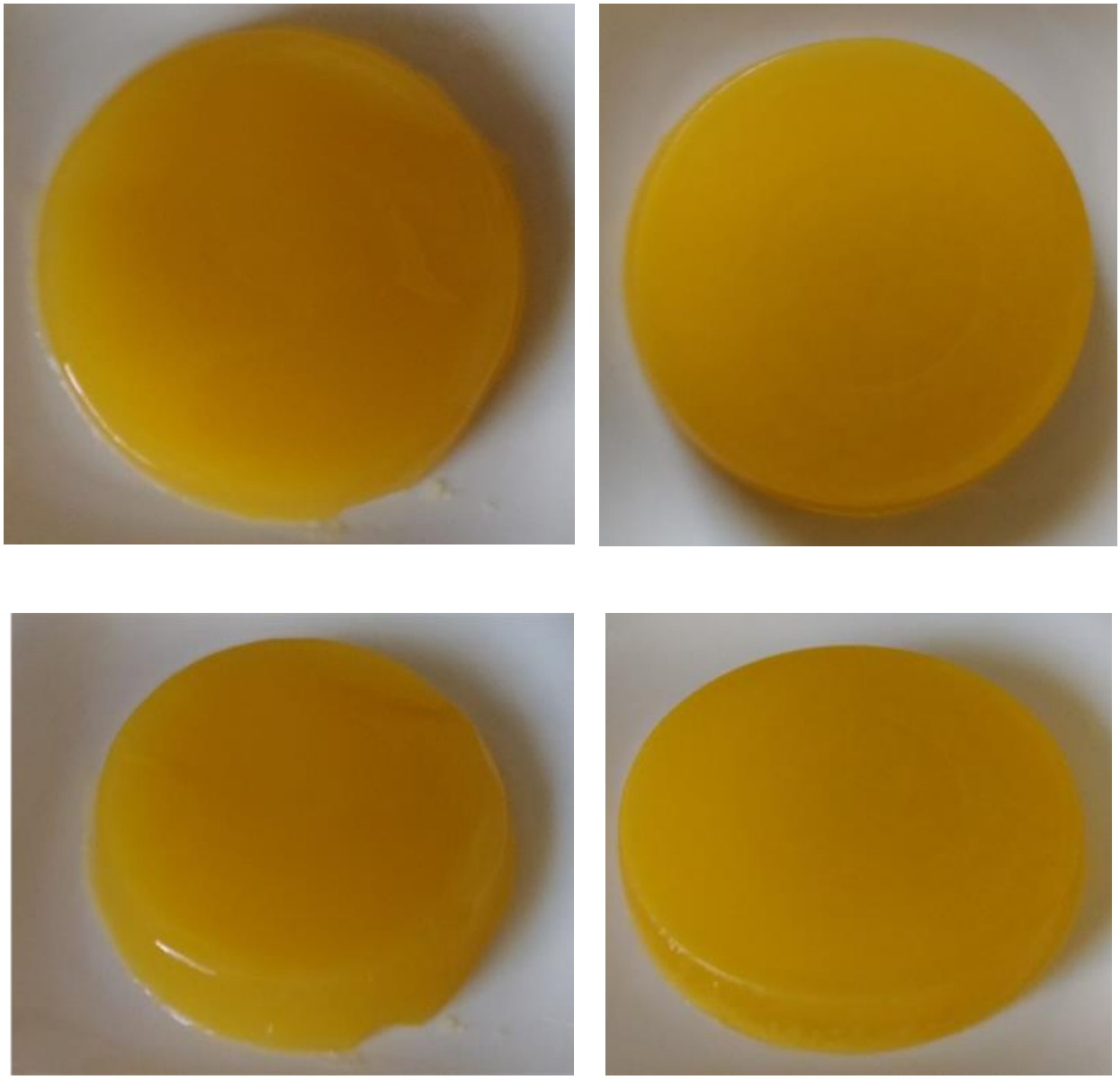


Figure 1. Profilogram of Jelly Desserts

The obtained product possessed pleasant gastronomic characteristics. The taste profilogram (see Figure 1) demonstrates the unusual combination of taste profiles of the main components of the product formula – the sour-milk taste of acid whey was perfectly combined with the taste of orange (Surmacka Szczesniak, 2002).

The test sample was considered the best one judging by its organoleptic properties – it had a distinct citrus flavour, natural color and taste, which is characteristic of the raw materials used.



Control Sample Test Sample

Figure 2. Photos of the control and test samples

Adding citrus fibre to the formula increased the density of the dessert, without separation of the liquid. Adding the acid whey gave the dessert a pleasant milk taste, increased sweetness and reduced the sour taste of the jelly.

According to the results, we can conclude that in the course of the study we obtained an enriched jelly dessert, containing acid whey and citrus fibre. Acid whey increases the nutritional and biological value of the product, while citrus

fibre not only improves the functional and technological characteristics of the dessert, but also enriches it with valuable dietary fibre. The organoleptic evaluation indicates that such dessert can be used in the everyday diet of a wide range of consumers.

4. Conclusions

We have for the first time developed and tested the technology of obtaining the enriched jelly dessert based on the acid whey and citrus fibre.

Prepared gelatin was added to the whey heated with sugar to 60 °C. After the gelatin dissolved, juice extracted from oranges and the citrus fibre powder was added. Then citric acid was added and the mixture was stirred constantly for 2 minutes. The mixture was allowed to cool to room temperature, then poured into molds and cooled off.

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Jelly based on milk whey is recommended for all population groups as a functional product for increasing immunity, especially for people with connective tissue diseases, cardiovascular diseases, high blood pressure, metabolic disorders, and diabetis.

Thus, the developed product along with the functional properties had an increased biological and nutritional value and possessed high organoleptic characteristics.

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